



Galaxy Cluster Science Results from the Dark Energy Survey

Yuanyuan Zhang
Schramm fellow, Fermilab
on behalf of the DES Cluster Working Group



Galaxy Cluster Science Results and Progresses from the Dark Energy Survey

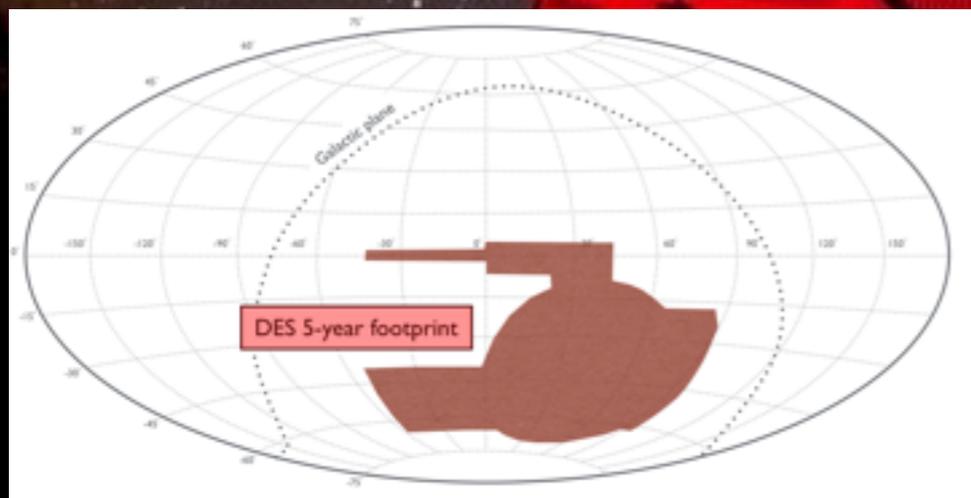
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Galaxy Cluster Science Results and Progresses from the **Dark Energy Survey**

A survey of 5,000 deg² in g, r, i, z, Y, ~500 nights in 5 years.
Using the Blanco telescope and DECam. 25 institutions on 4 continents.

- Official start in 2013. Finished 4 years of observation.
- Science-Ready data product from Year 1 (40% depth, ~ 1/3 coverage).
- Internal release of Year 0 to 3 data (half depth, full footprint coverage).
 - Public data release ~ 2017 Dec.
- Supernovae survey: 30 deg², on sky since 2012.

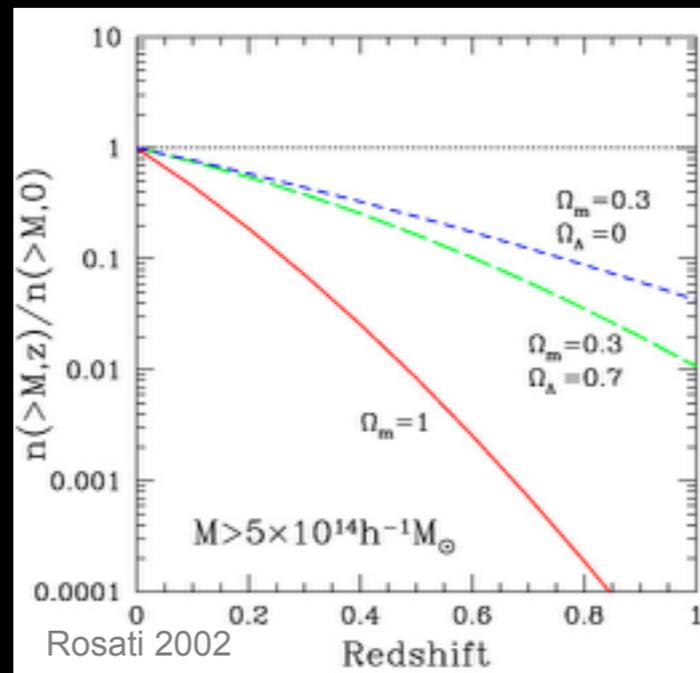


DES images 1/8 of the sky,
finding ~ 30,000 rich clusters
to $z=1.0$ in future data.

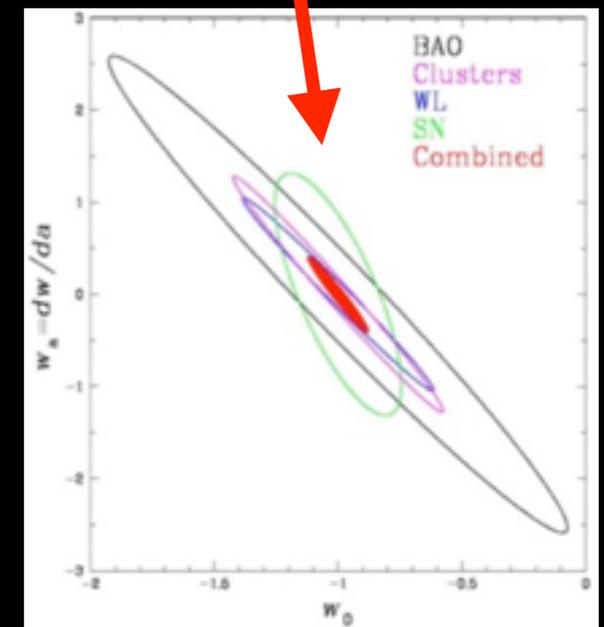
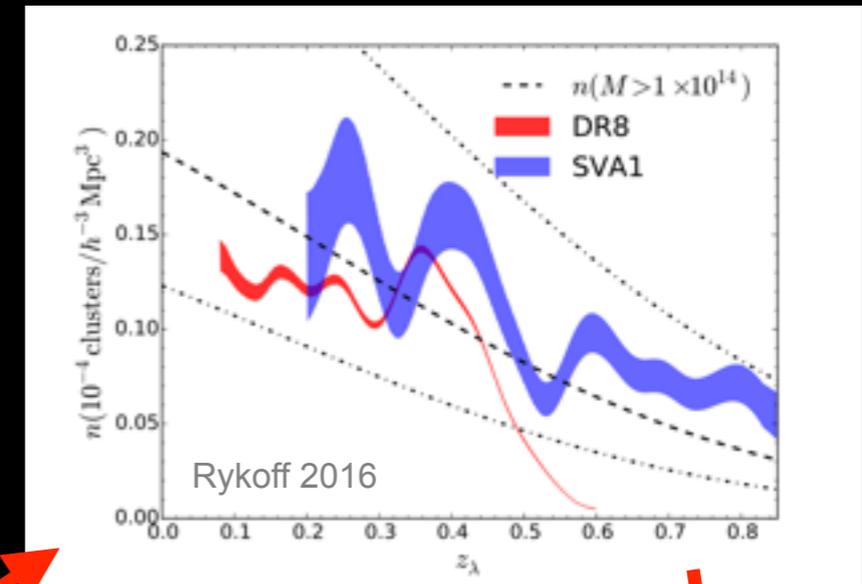


Galaxy Cluster Science Results and Progresses with the Dark Energy Survey

The key goal of DES cluster analyses is to constrain CDM cosmology models.

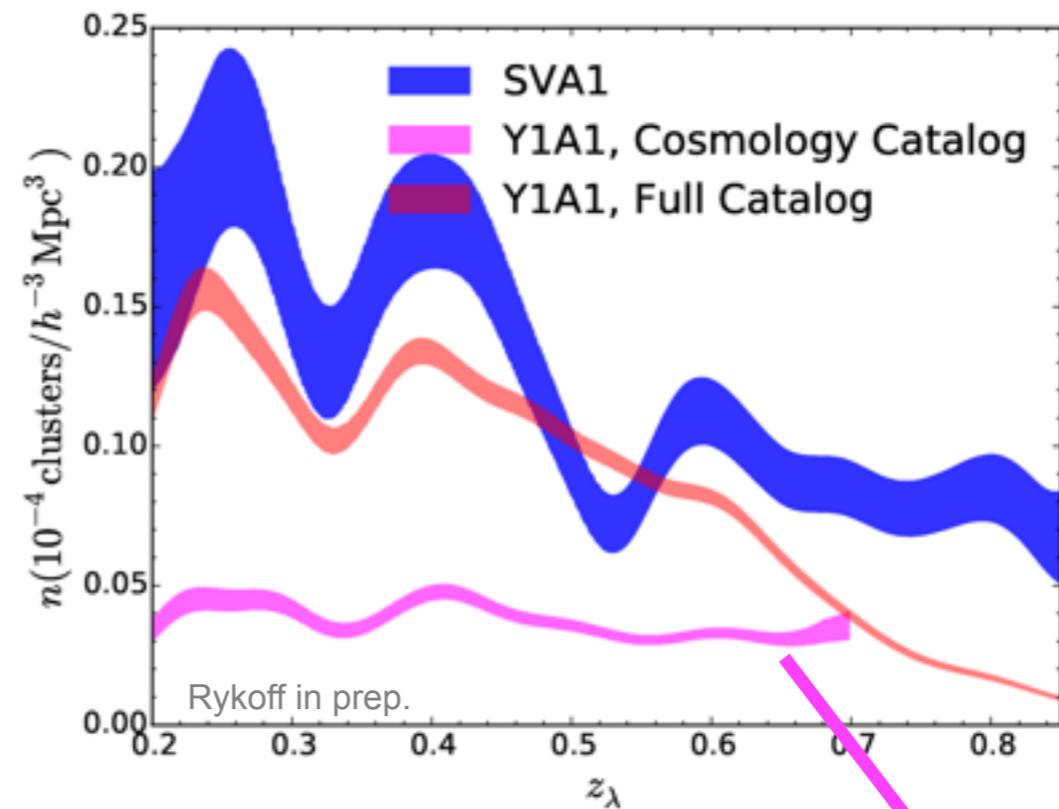
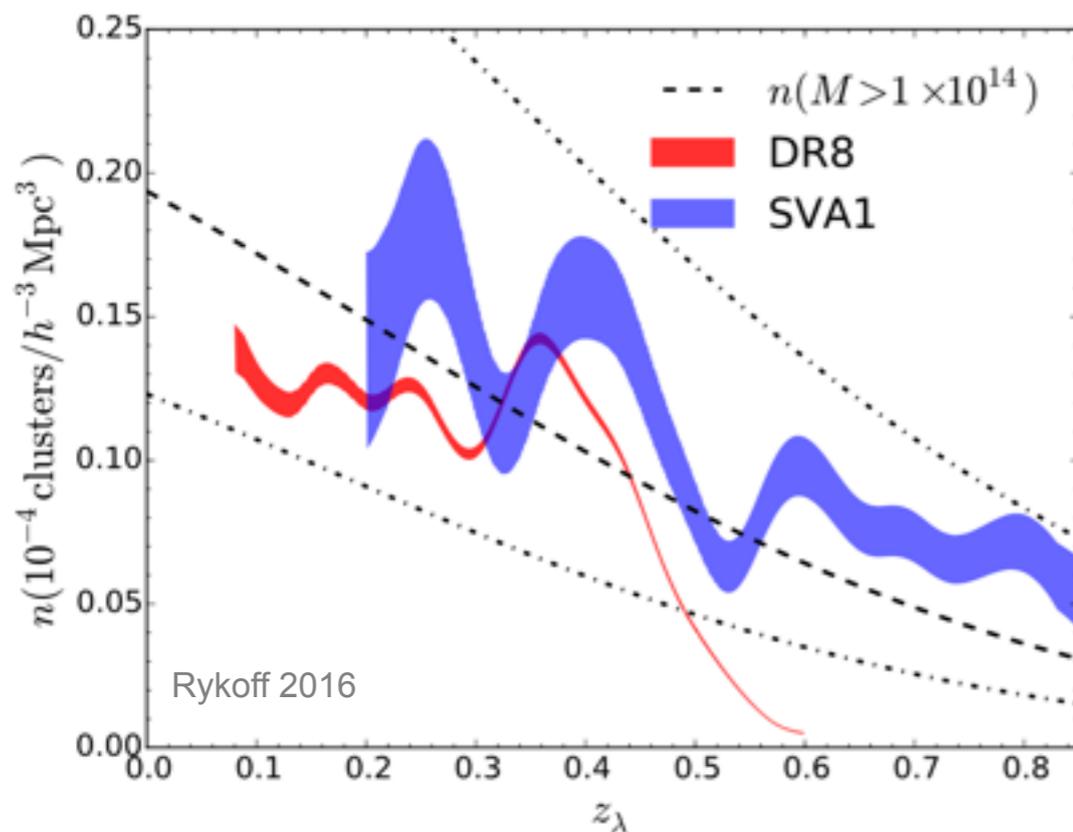


The abundance of clusters is sensitive to cosmology models.



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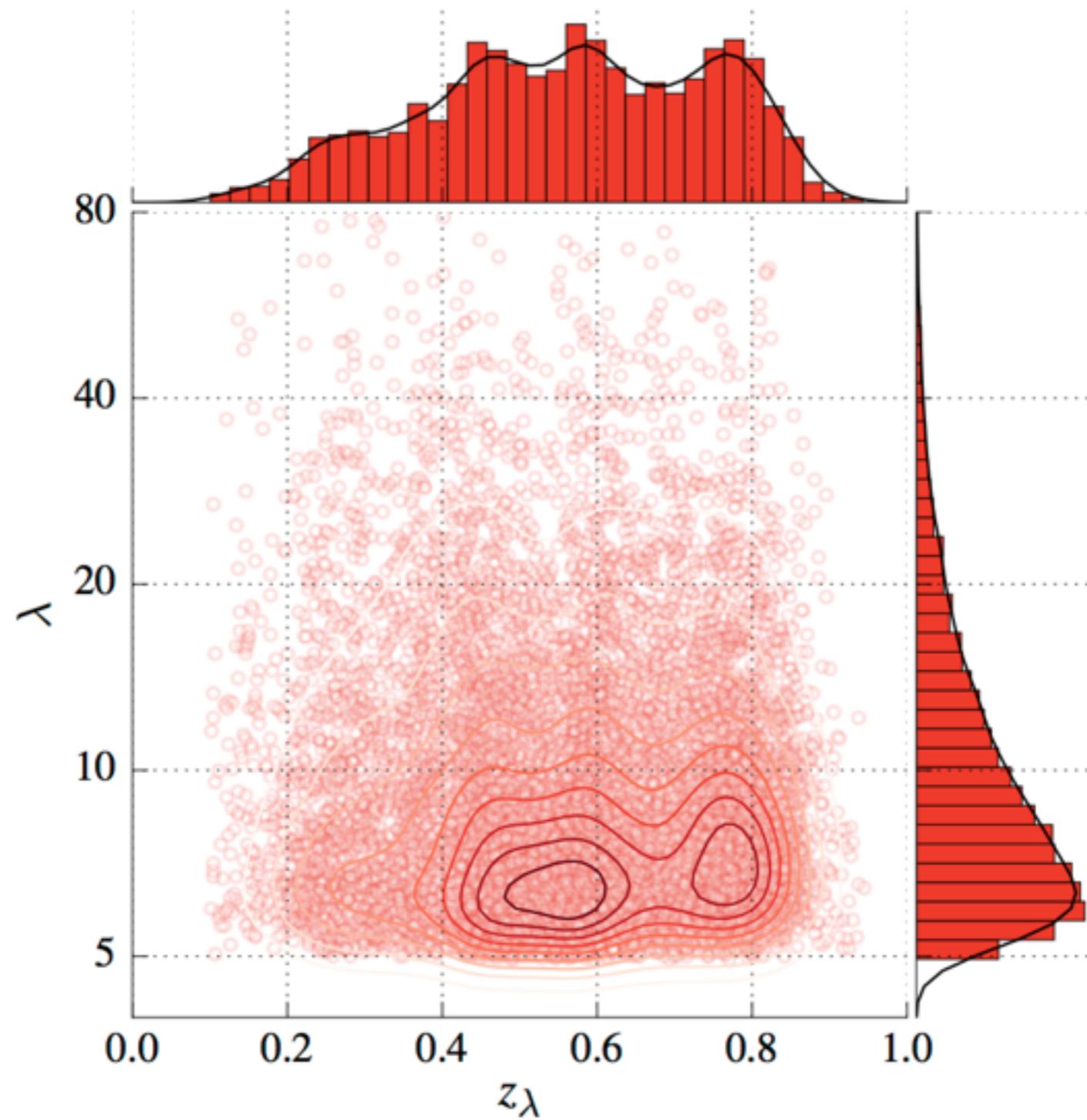
DES finds clusters to $z \sim 0.7$ and beyond with Year 1 data.



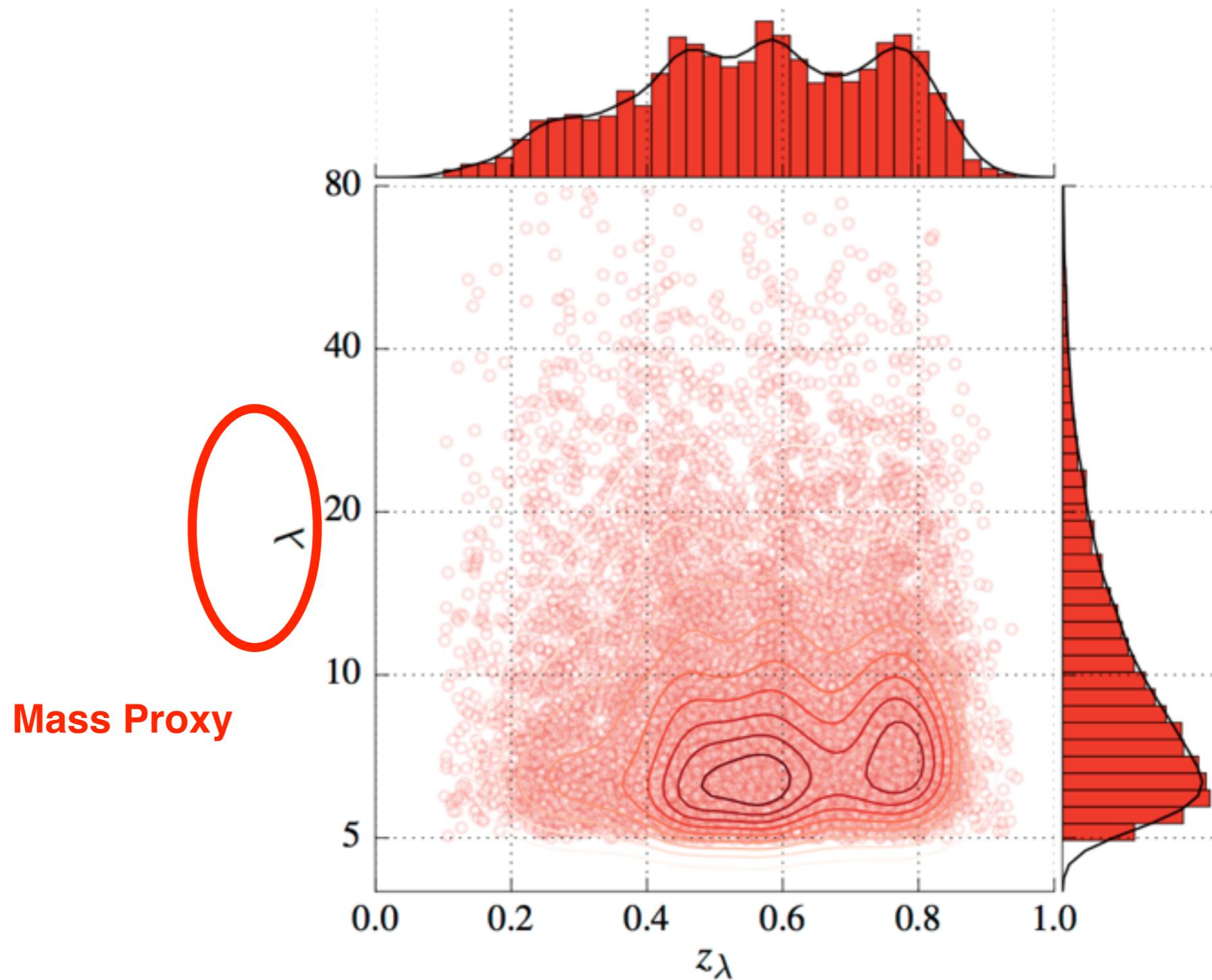
For Cosmology analyses.

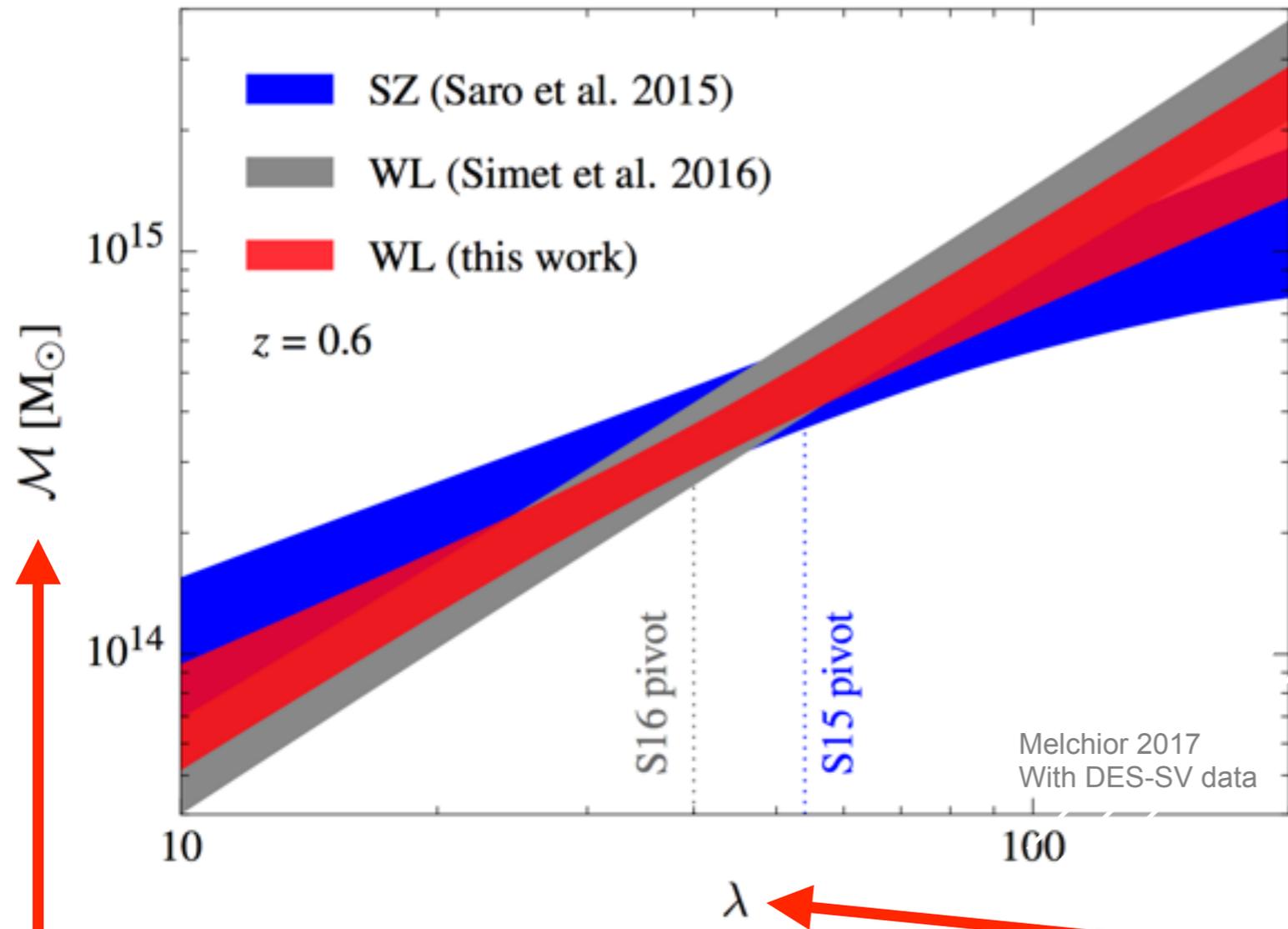
Clusters are also identified with the:
WAZP cluster finding algorithm (Busti and Aguena et al.)
VT Cluster finding algorithm (Sores-Santos et al.)

DES cluster cosmology uses **richness** as a mass proxy.

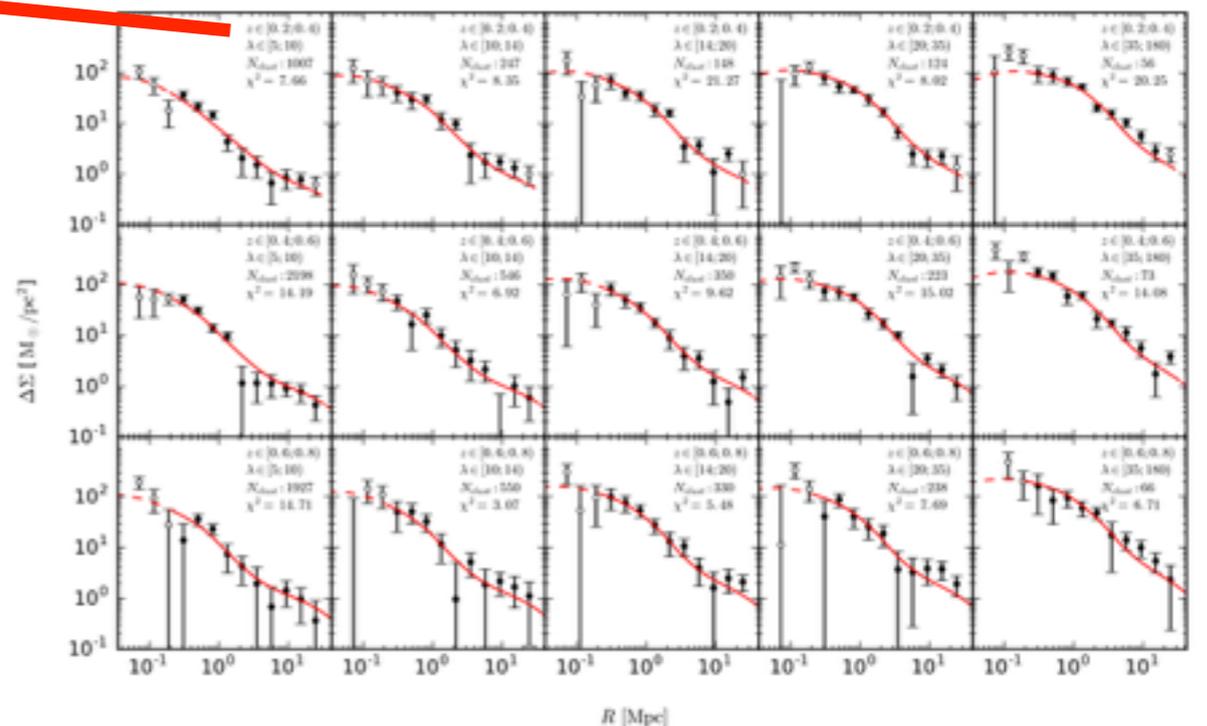


DES cluster cosmology uses **richness** as a mass proxy.

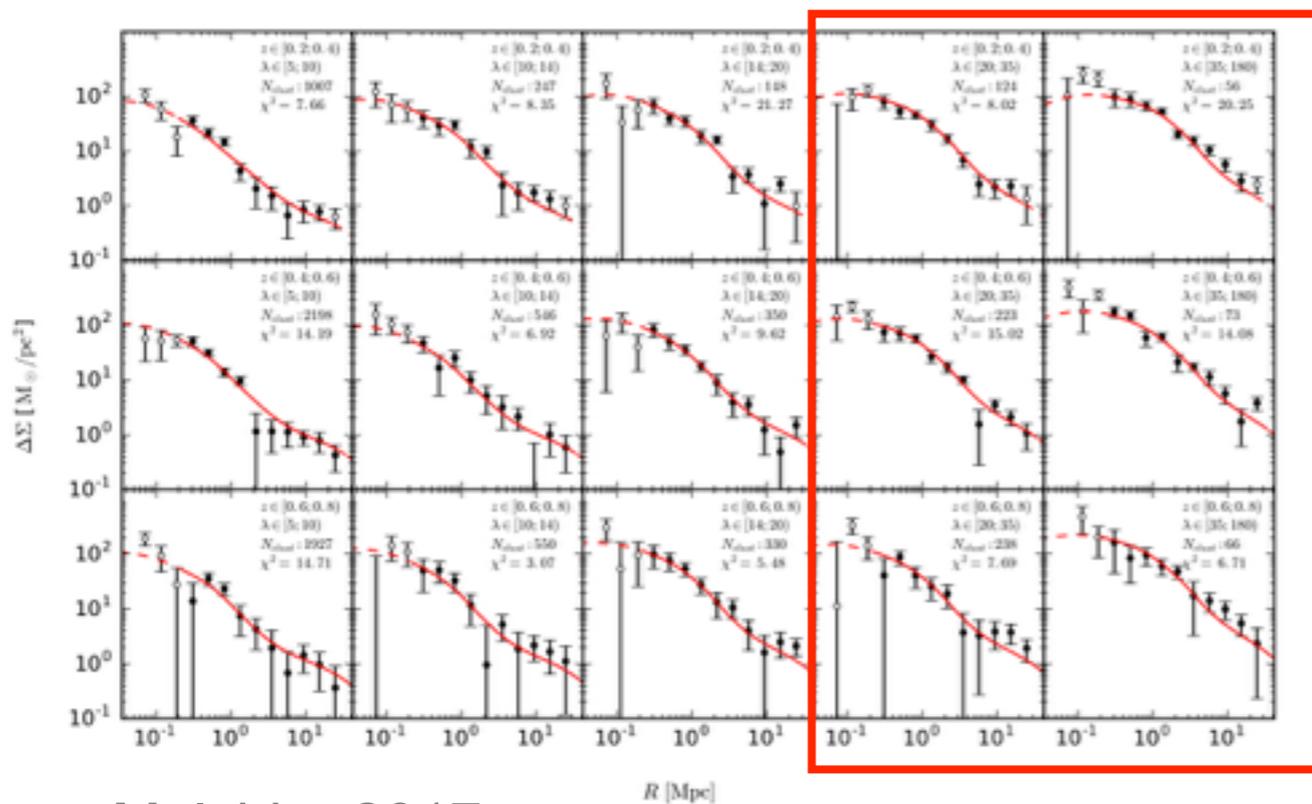




- **DES cluster cosmology uses richness as a mass proxy.**
- **DES constrains richness - mass relation from Weak Lensing measurements.**



WL mass profiles based on DES-SV data.

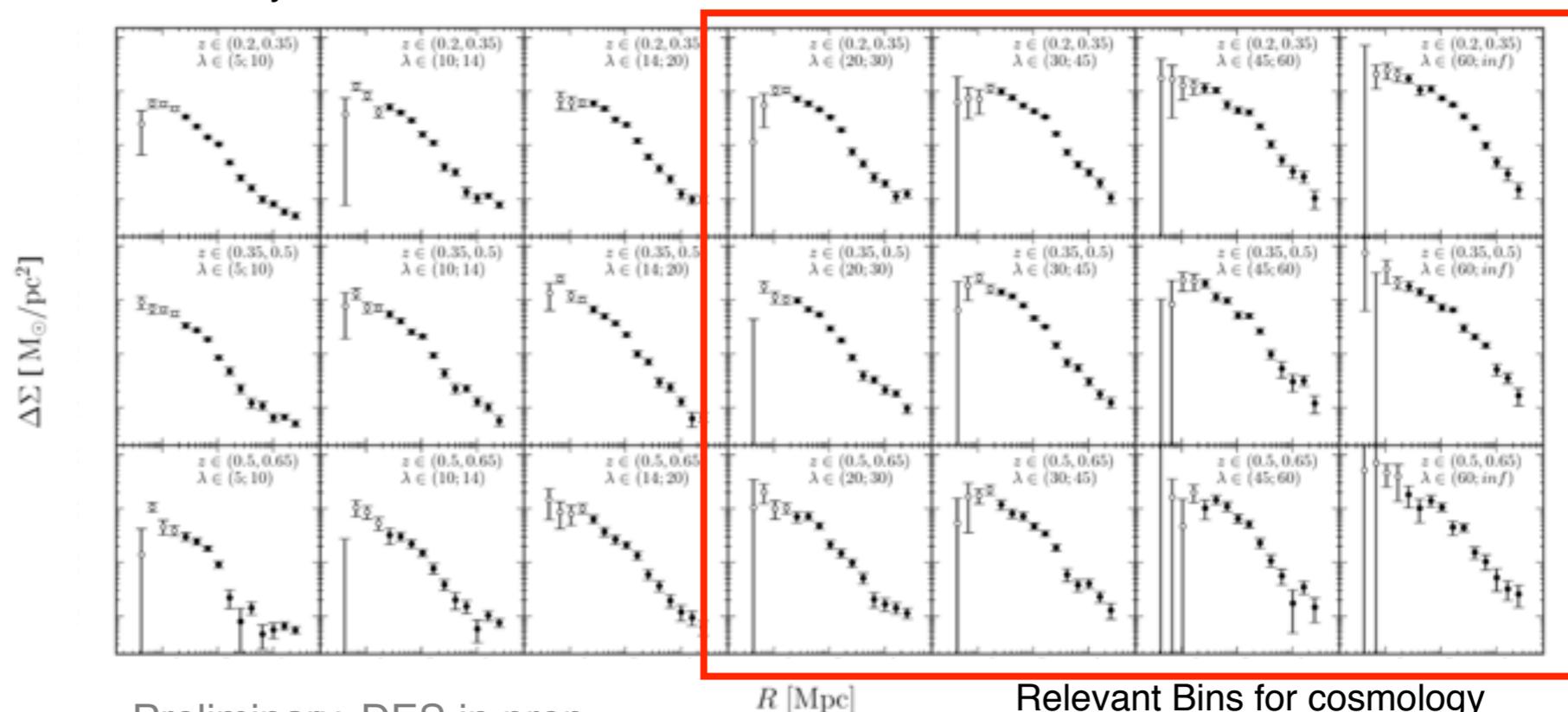


Melchior 2017

Relevant Bins for cosmology analyses.

- Significant improvements of WL mass measurements from Y1 data.
- Input to cluster cosmology analyses.

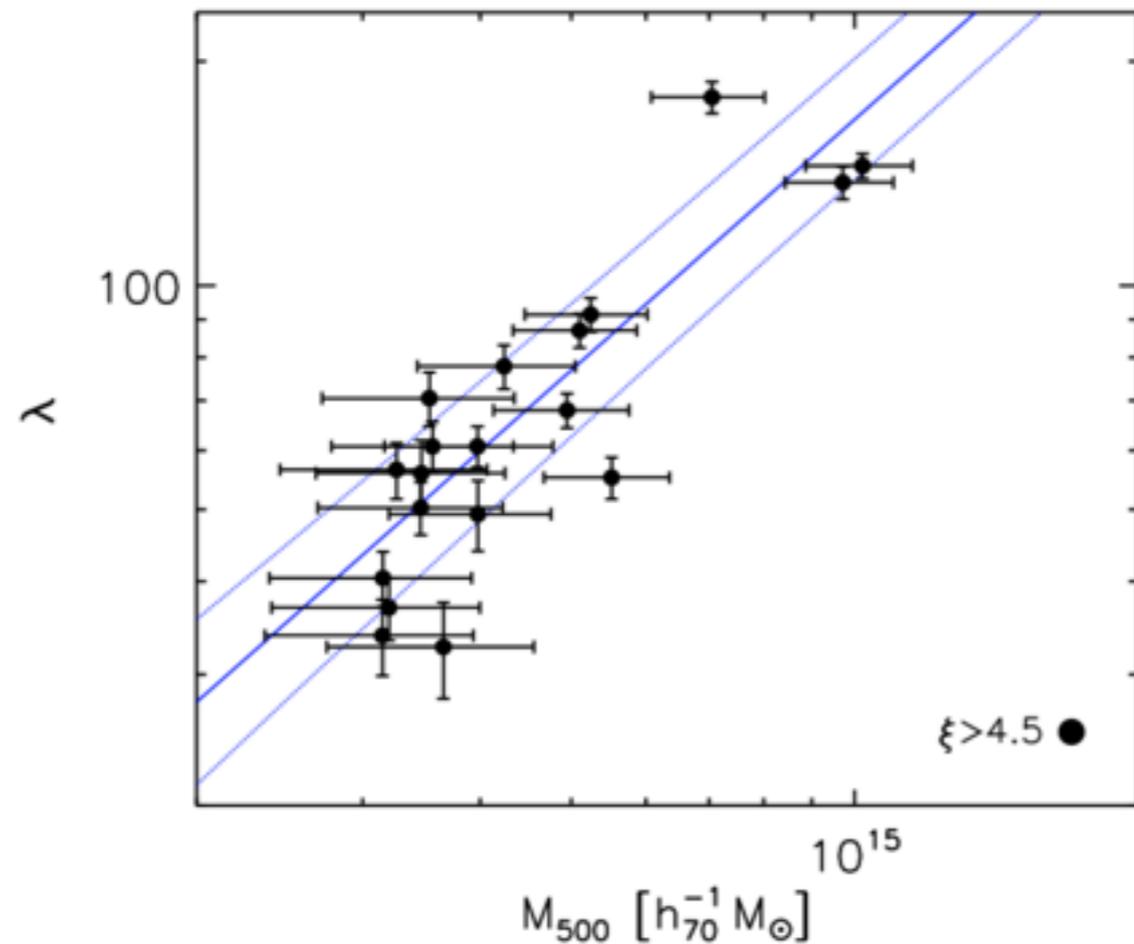
WL mass profiles based on DES-Y1 data.



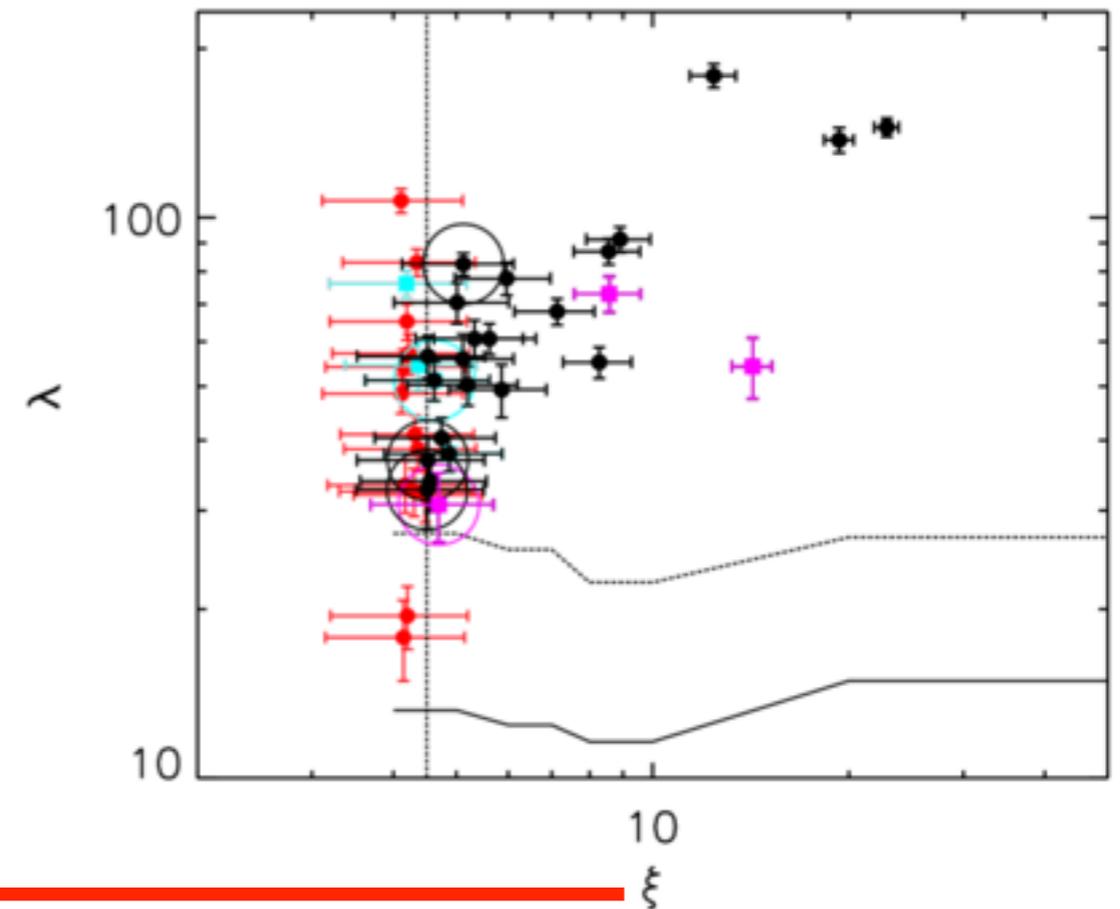
Preliminary, DES in prep.

Relevant Bins for cosmology analyses.

Overlaps between DES and multi-wavelength surveys allow us to further characterize the Richness - Mass relation.

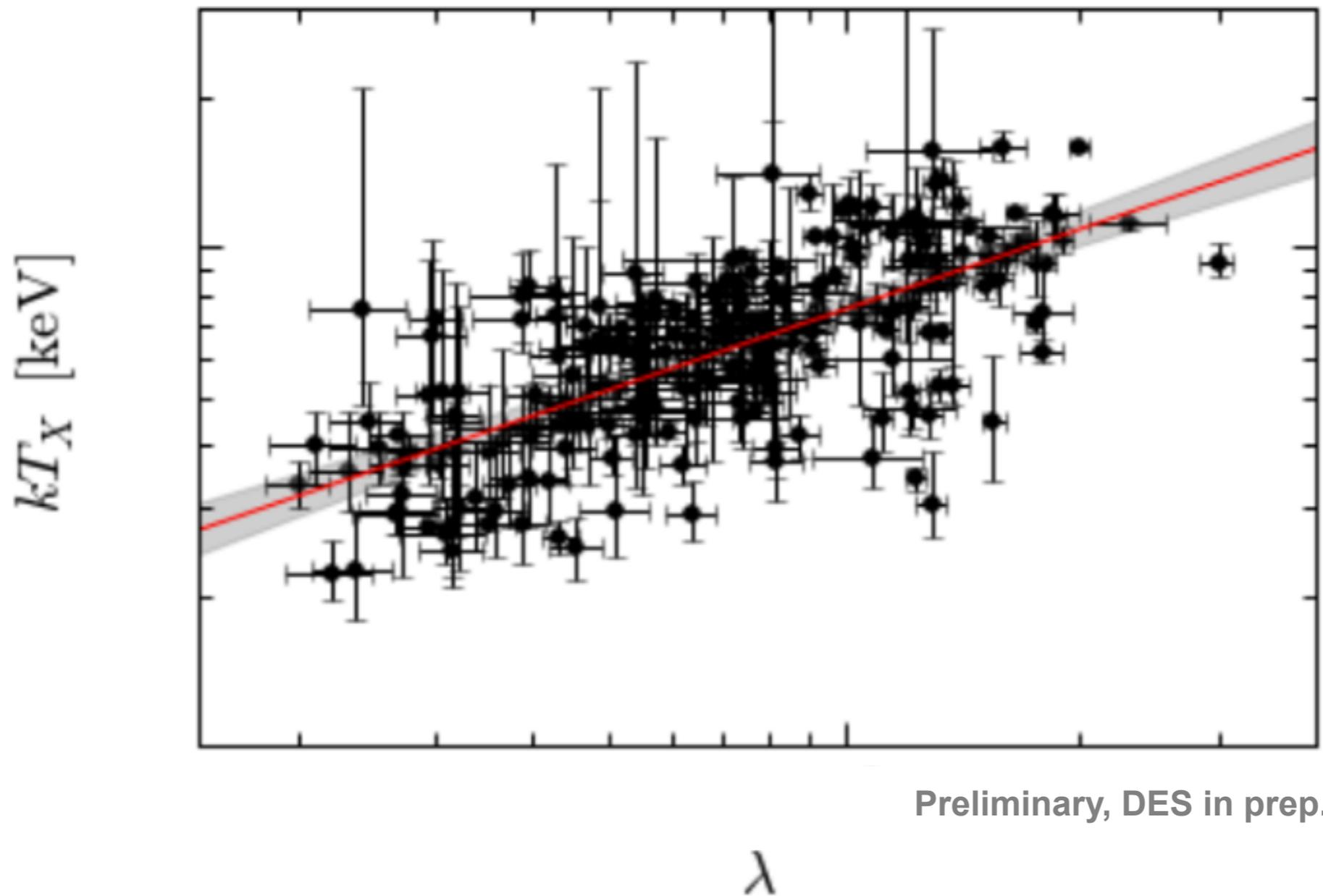


$M_{500} [h_{70}^{-1} M_{\odot}]$



Cluster mass inferred from CMB tSZ detection significance.
(based on SPT data)

Overlaps between DES and multi-wavelength surveys allow us to further characterize the richness - mass relation.

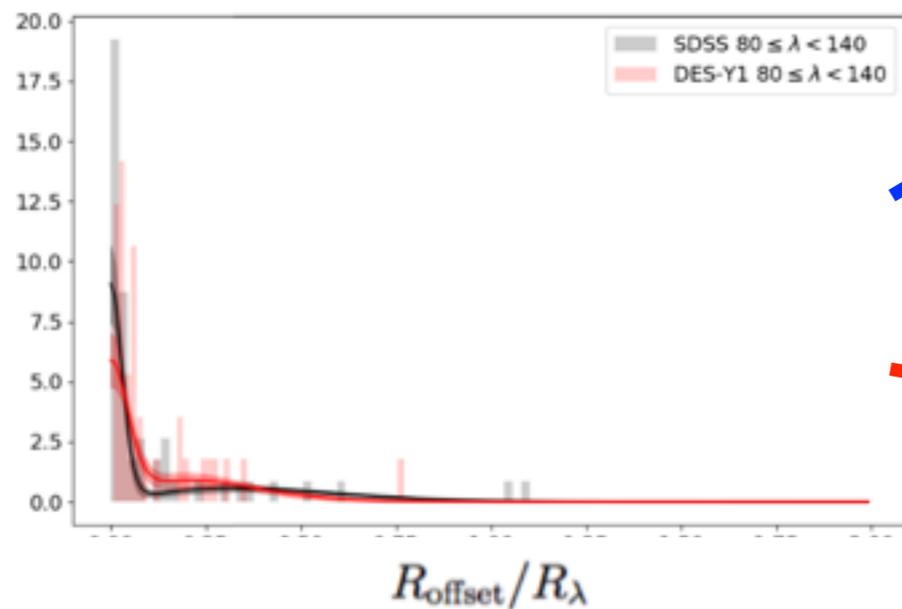


Preliminary, DES in prep.

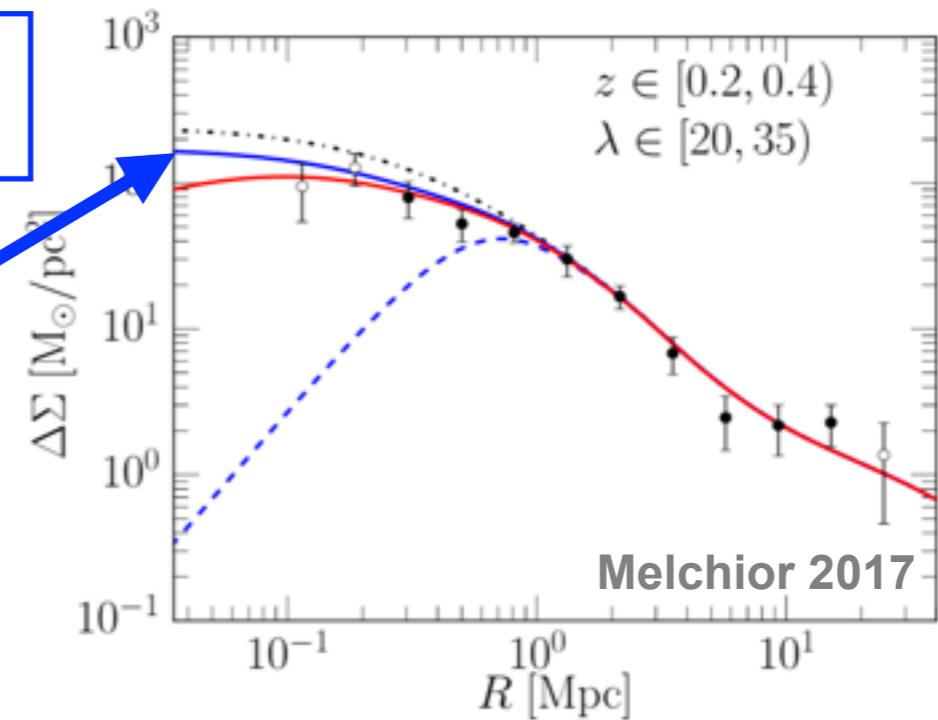
More precise results to come from Y1 data.

Overlaps between DES and multi-wavelength surveys helps understanding the mis-centering characteristics.

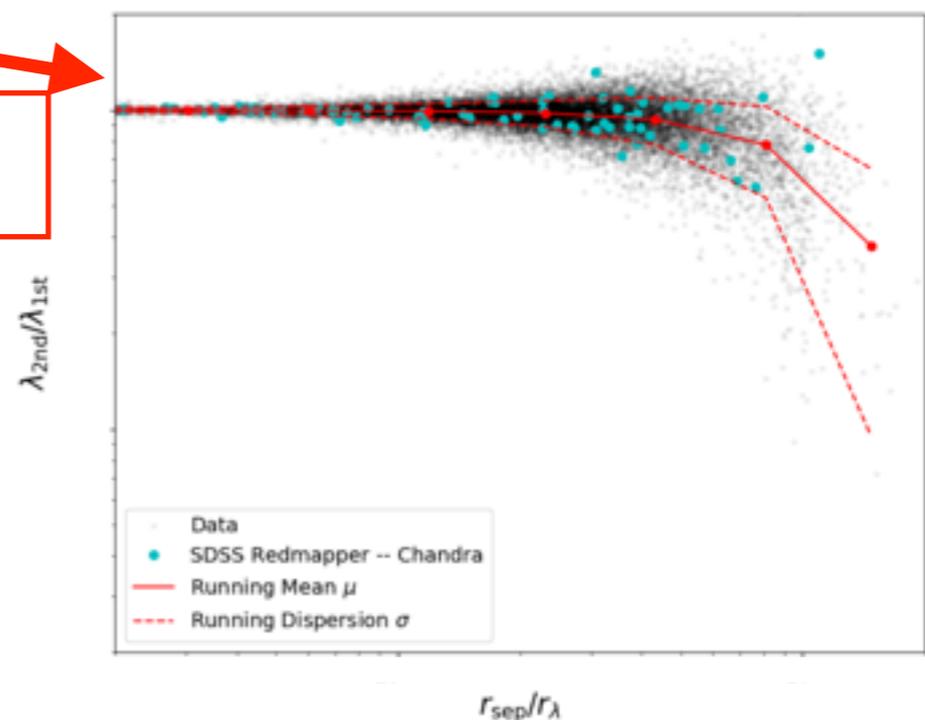
Preliminary, DES in prep.



Mis-centering affects mass calibration.



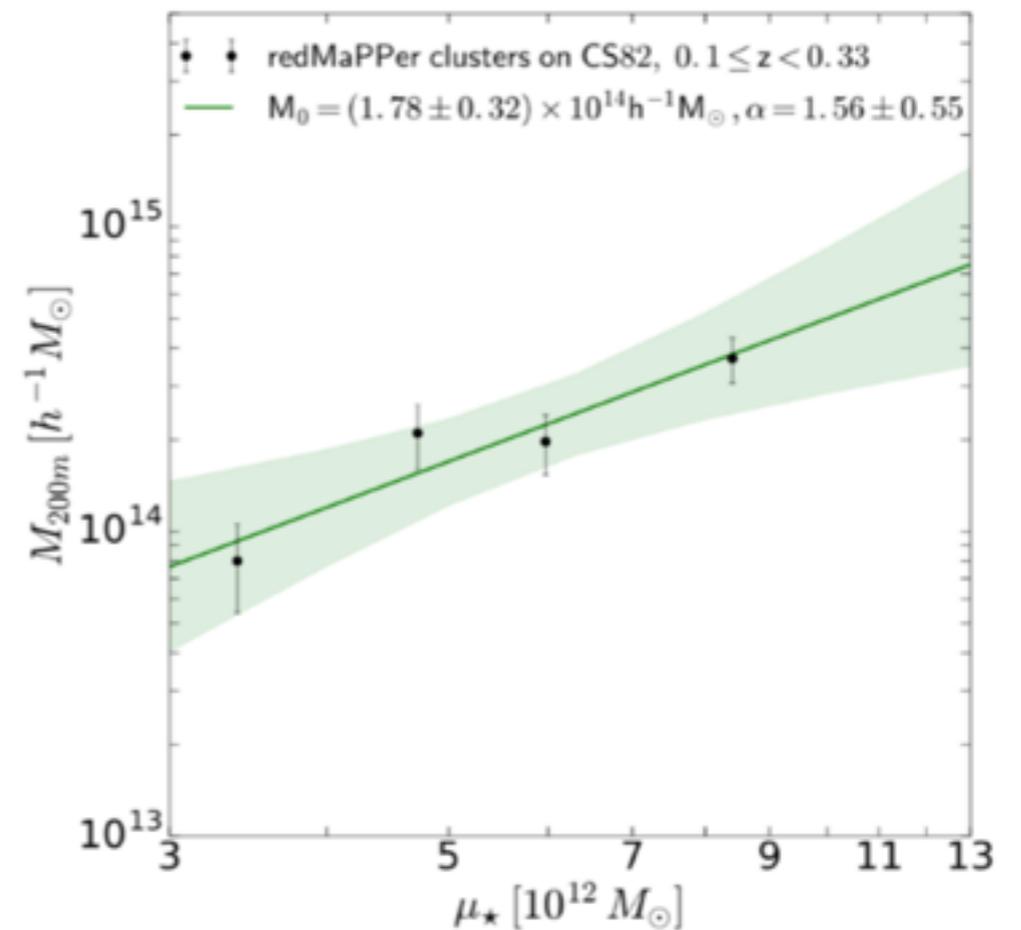
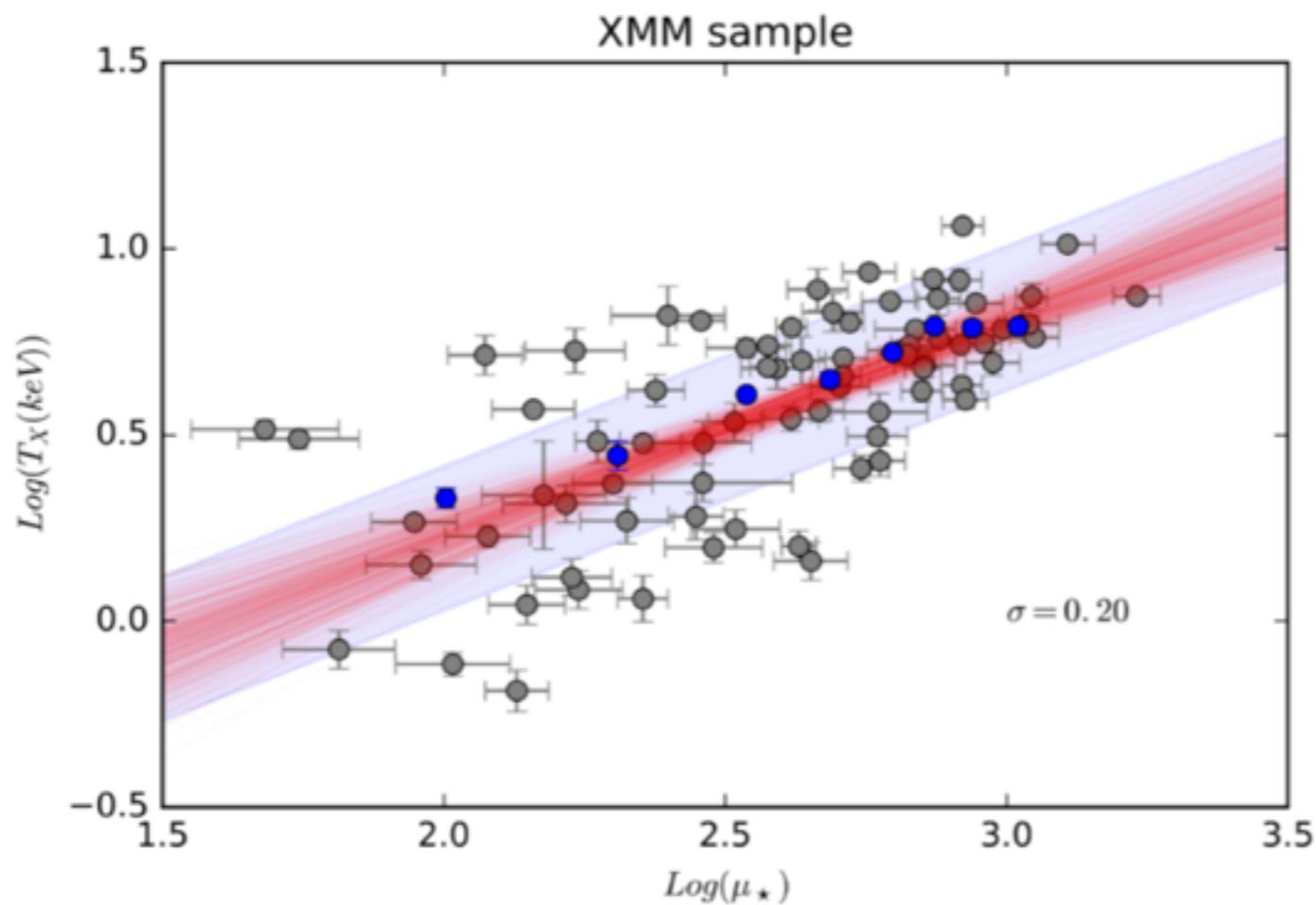
Mis-centering affects richness estimation.



Offsets to X-Ray observation centers are used for evaluating DES centering probability.

Preliminary, DES in prep.

Towards future cosmology analyses: Developing and understanding new optical mass proxies

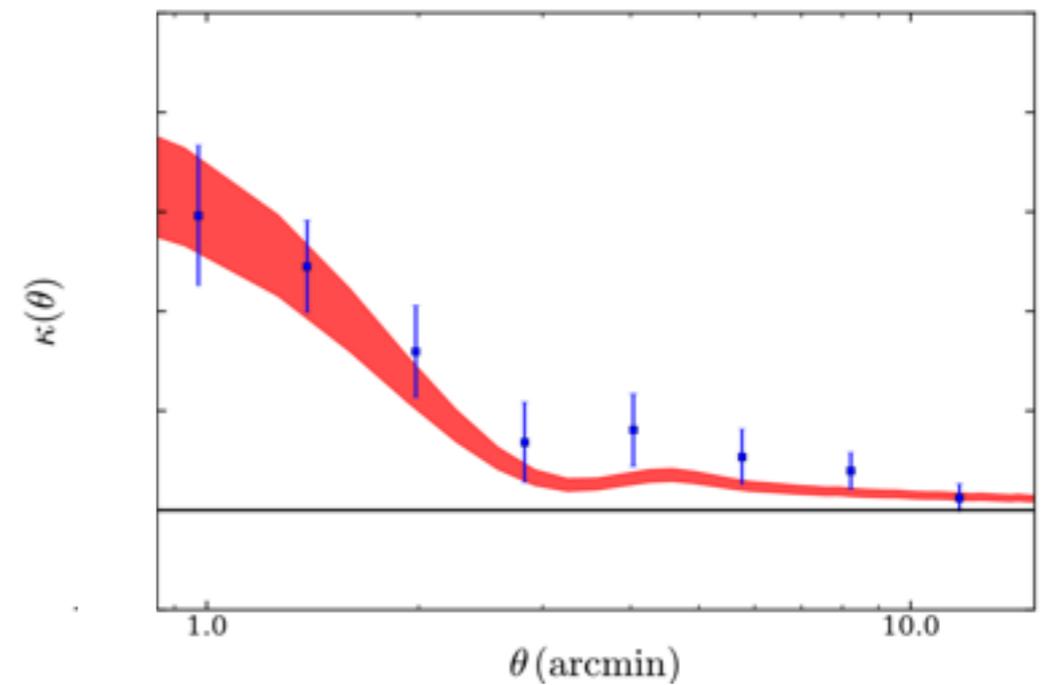
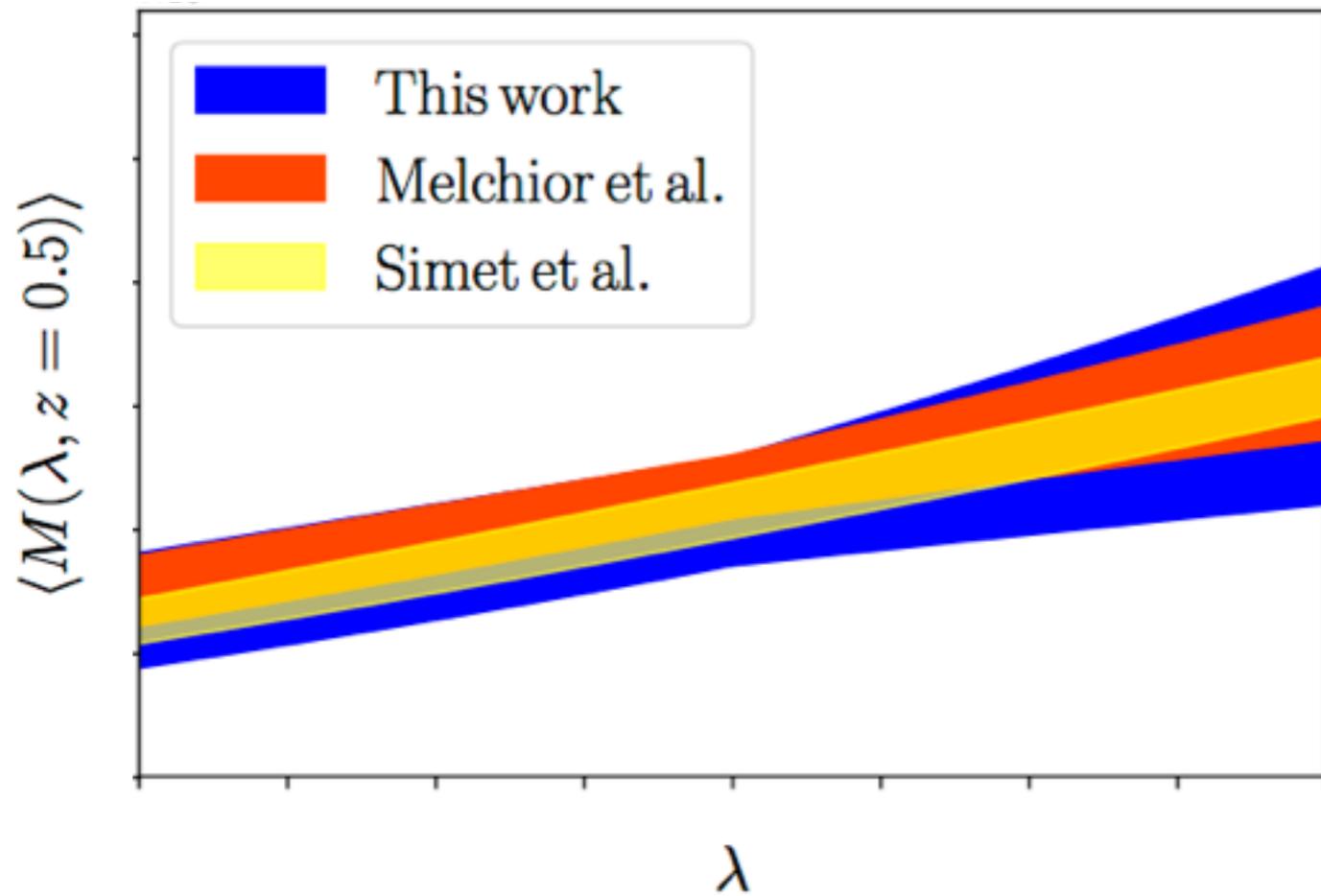


Understanding cluster total stellar mass as a mass proxy.

Preliminary.

Talk by Huan Lin / Antonella Palmese on July 31

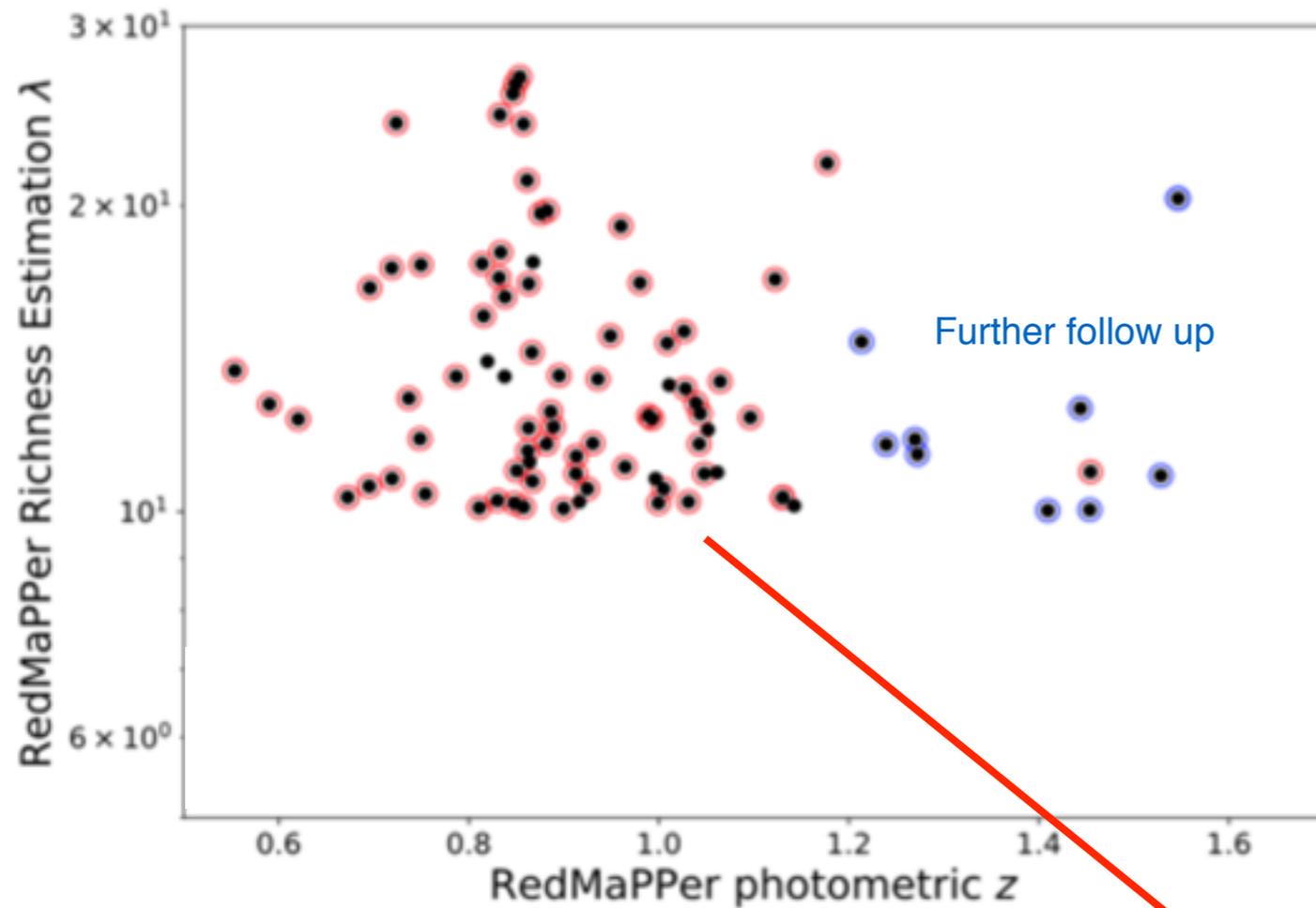
Towards future cosmology analyses: Developing and understanding new mass calibration approaches.



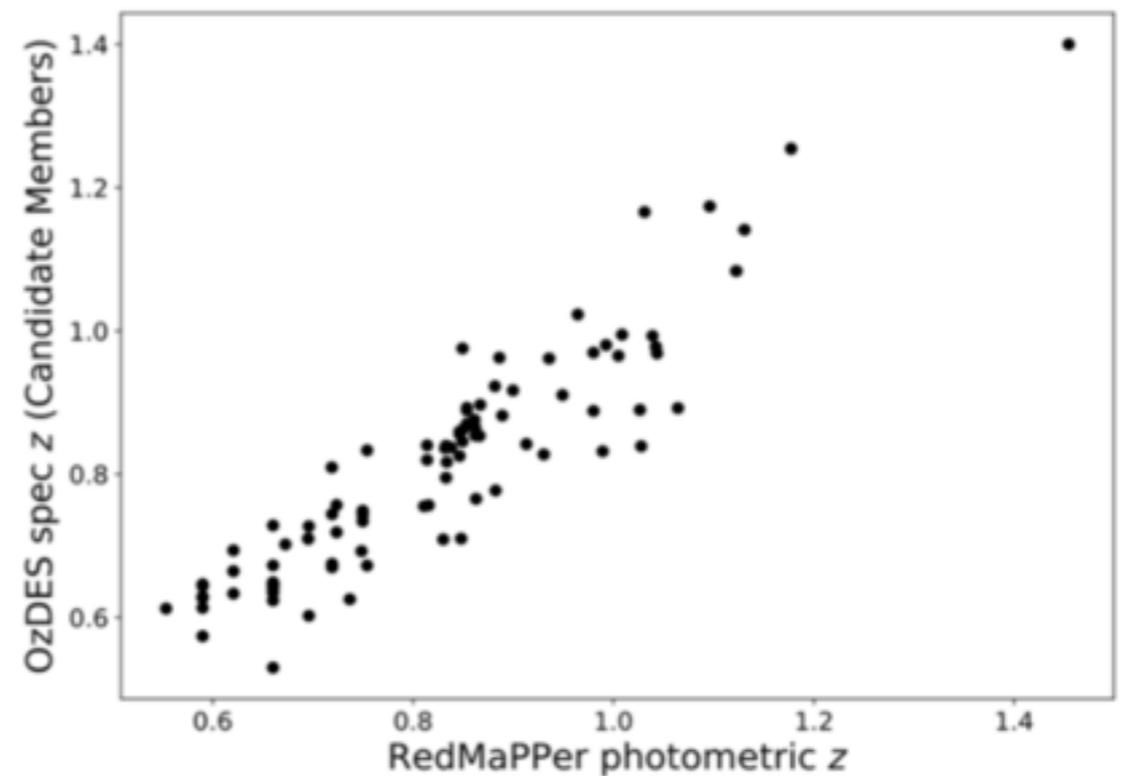
Calibrating cluster mass proxies with CMB lensing measurements.

Baxter et al. in prep.
Results going public soon.

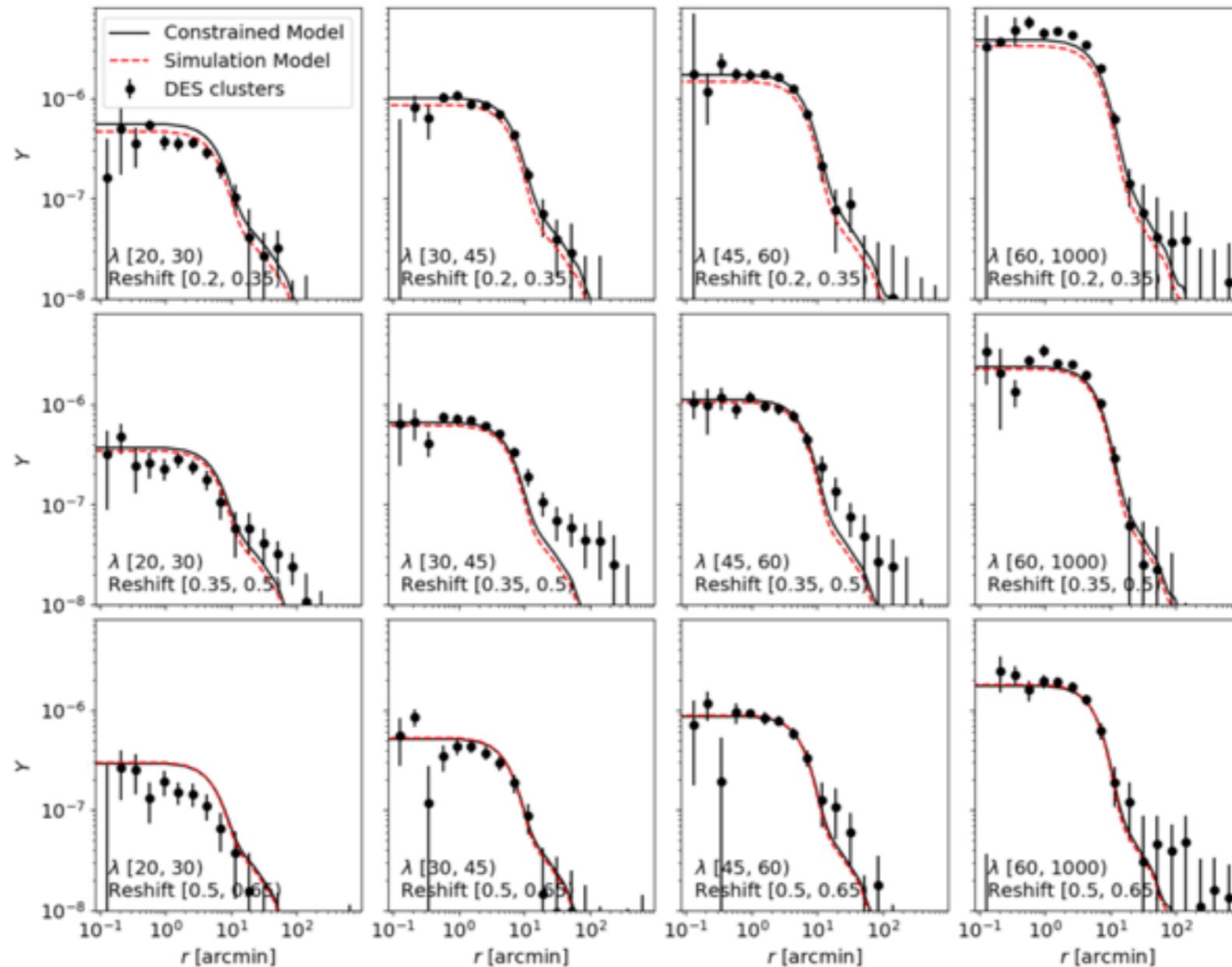
Towards future cosmology analyses: Extending to higher redshift.



Searching for low mass cluster candidates beyond $z \sim 1$ with DES data (Through combination with infra-red surveys).



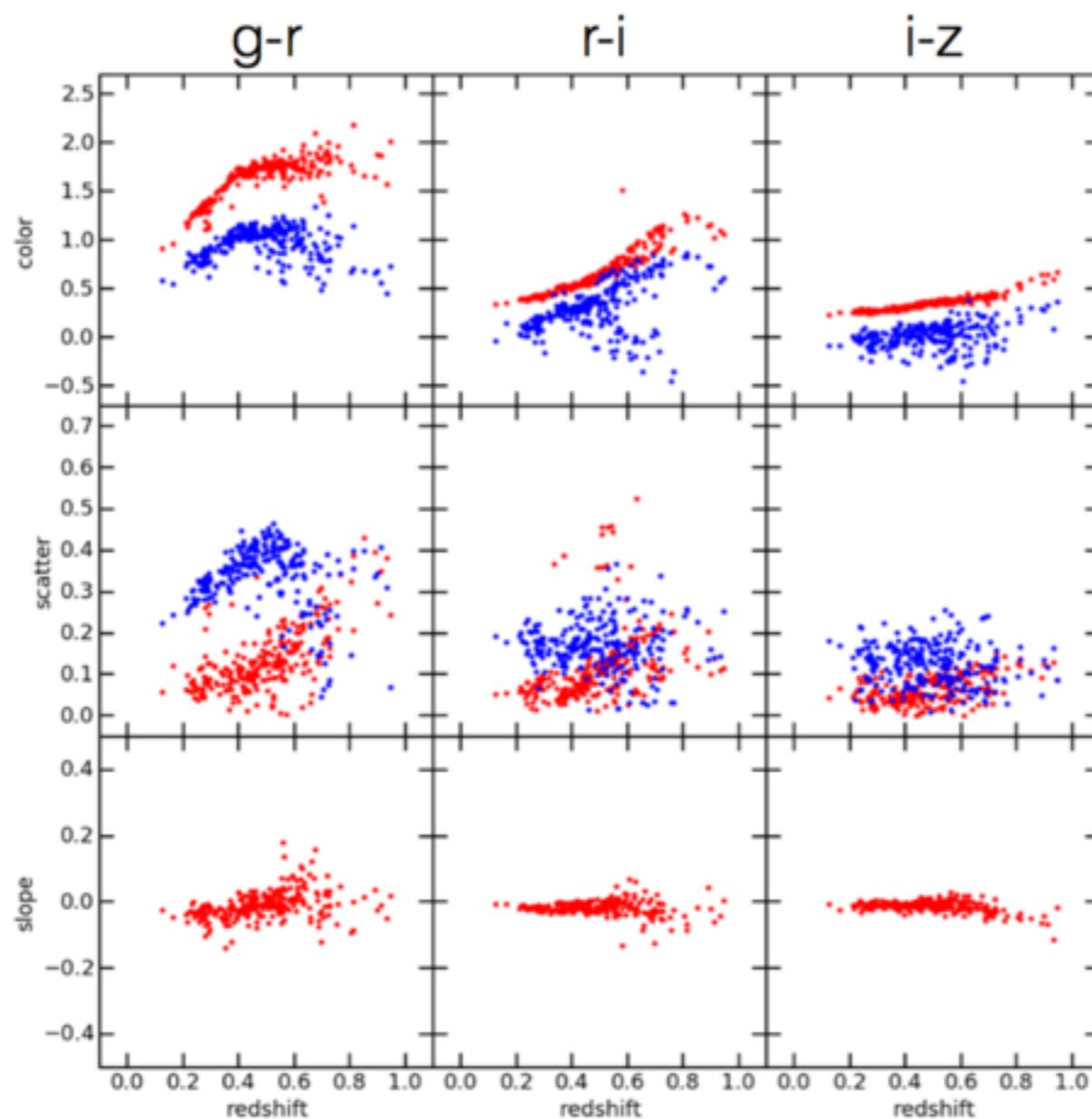
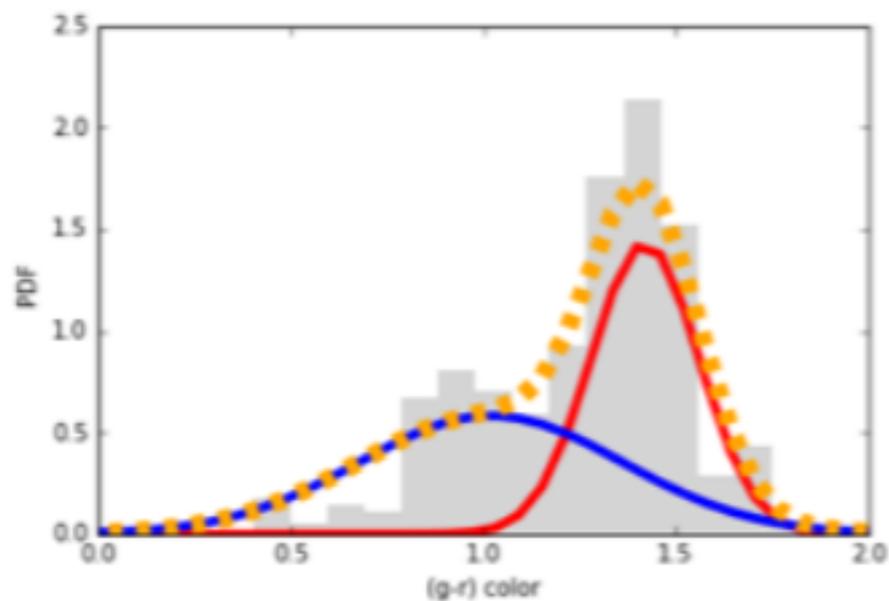
DES helps understanding CMB tSZ signals from galaxy clusters.



Cross-Correlation between DES clusters and Planck tSZ maps.

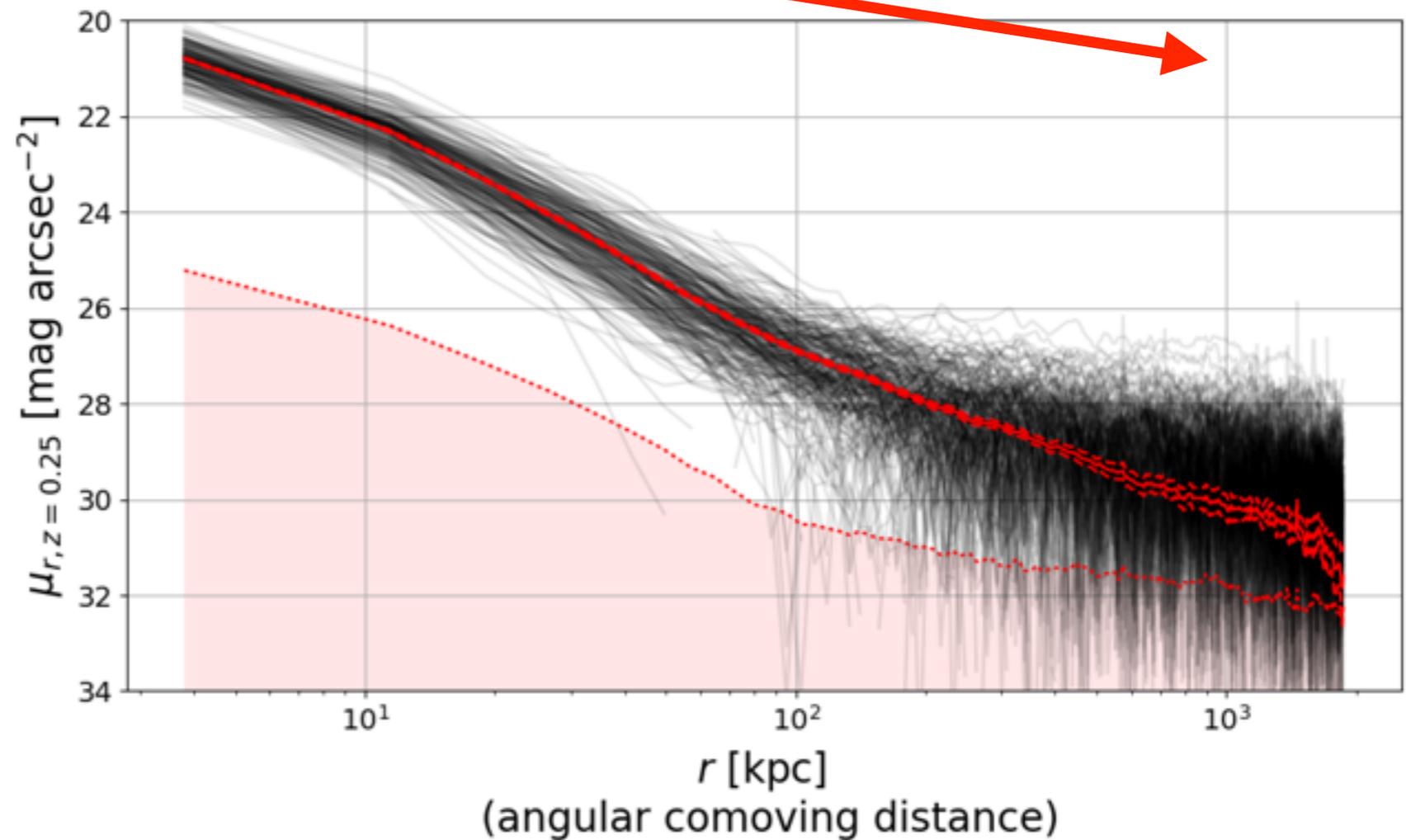
Preliminary, DES in prep.
See Poster by Vinu Vikram.

DES helps understanding the evolution of cluster galaxies.



Color evolution of cluster galaxies.

DES helps understanding the evolution of cluster galaxies.



Detection of intra-cluster light.

Preliminary, DES in prep.



Galaxy Cluster Science Results and Progresses from the Dark Energy Survey

- Released science results from DES-SV data.
- Significant improvements with Y1 data — input to cosmology analyses.
- DES strives to understand both the cosmological and astrophysical aspects of galaxy clusters — currently with over 50 active projects.
- One talk on July 31. Two posters on the 2nd floor.